# Beach Hazards on the Great Lakes

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## Today's Goals

- Through examining past current-related incidents, leave with a knowledge of:
  - The most problematic current-related hazards on the Great Lakes
  - What conditions lead to the formation of high waves and dangerous currents
  - Where dangerous currents typically develop, and present recommended escape methods
- First: Information on the database used for the statistics used in this presentation

## The Great Lakes Current Incident Database (GLCID)

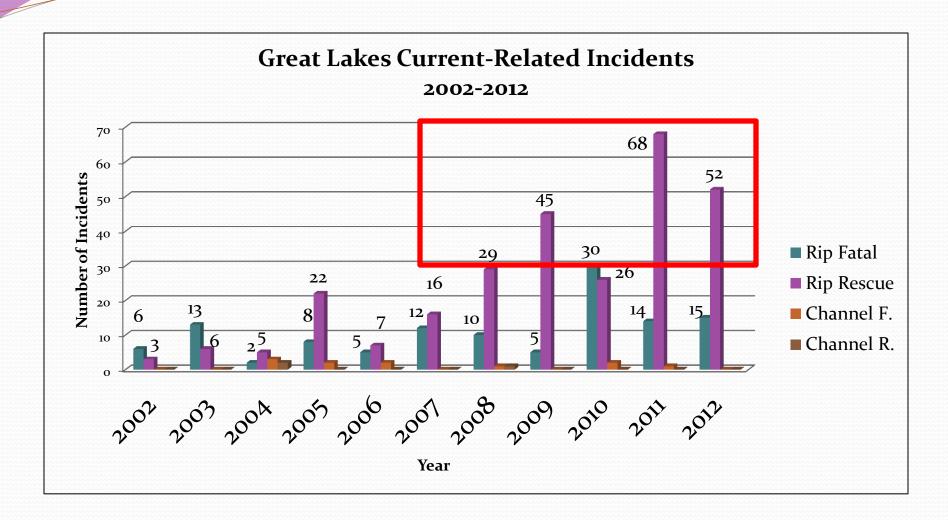
- A record of current-related rescues and fatalities across the Great Lakes 2002-2012
- Started by Dave Guenther [NWS Marquette] after the drowning of Travis Brown in the late 90's
- Items Collected in the database:
  - Victim information
  - Wind and wave data from nearest observation site and eyewitnesses
  - Current-type or location recorded: Channel currents, Structural currents, rip currents (classic and outlet)

### Limitations of the GLCID

- Subject to media coverage of incidents
  - Mislabeling incidents as rip currents (sensationalizing)
  - Not covering rescue incidents thoroughly or accurately
- Observations are limited in the nearshore environment
  - Observations may be unrepresentative of true environment
  - EX) Thunderstorm activity
- Remember: current related=currents may have only been a partial cause (likely a combination of waves and currents for many cases)

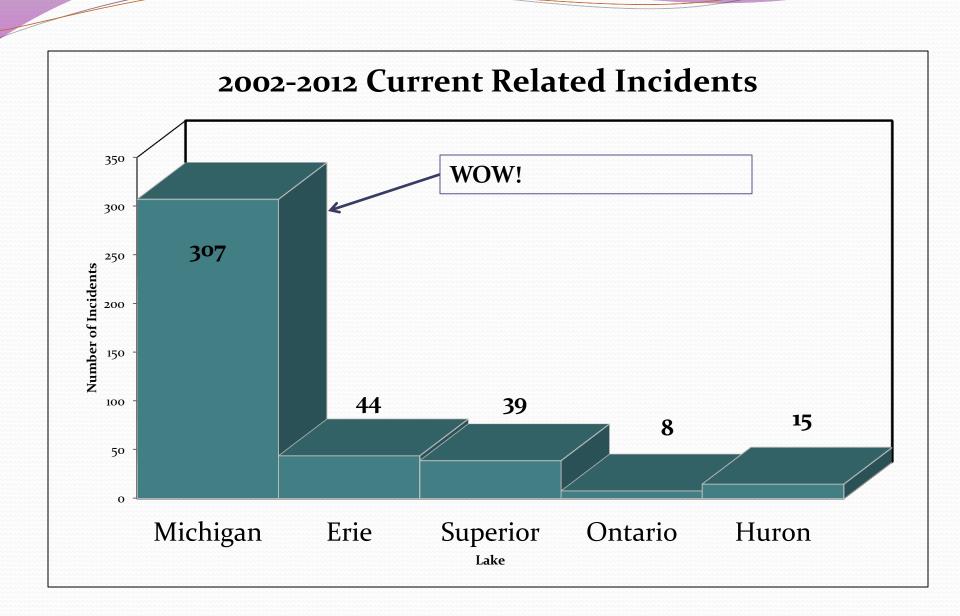
## An Overview of Great Lakes Current Related Incidents

What we've gathered from the database

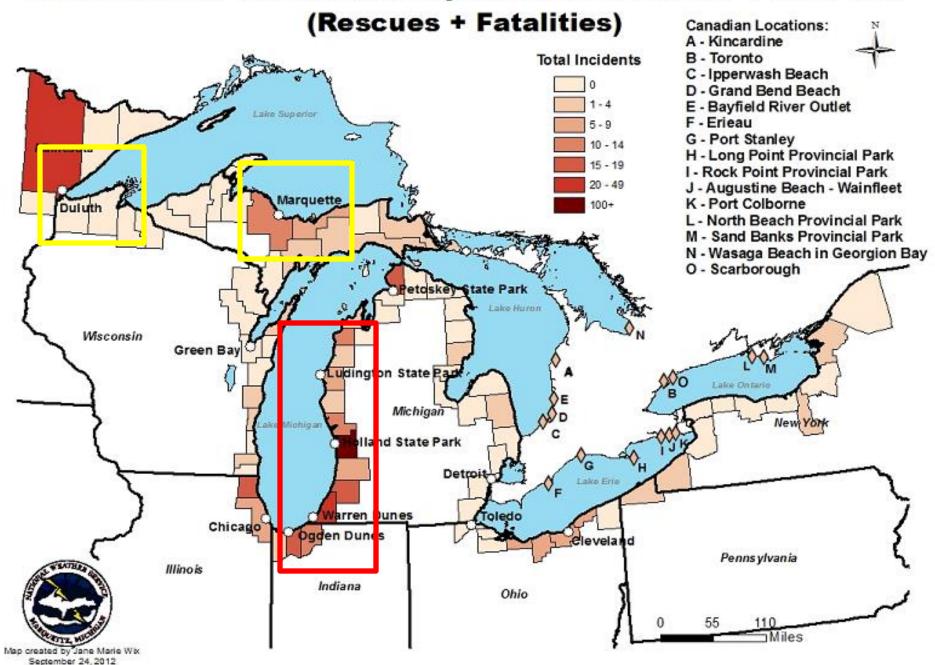


Total # incidents: 413
Total # rip current fatalities: 120
Total # rip current rescues: 279

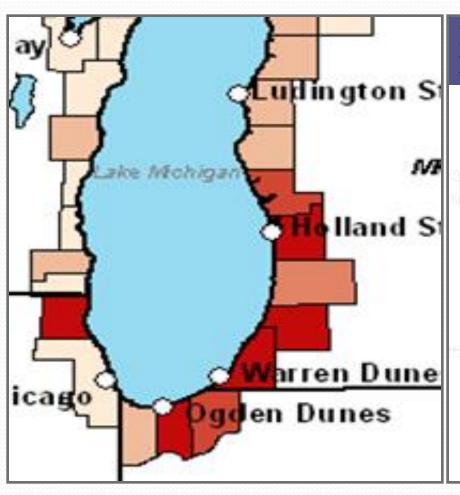
2002-2012 average: 11 rip fatalities/yr 2002-2012 average: <1 channel fatality/yr



#### Total Channel Current and Rip Current Incidents - 2002-2012



## **Popularity: Lots of People**





# High Waves & Dangerous Currents

The reasoning behind so many drowning fatalities and rescues

## **High Wave Action**

- Most Problematic
   Hazard on the Great
   Lakes
- Largely ignored by the media-esp. when a current mentioned
- Equal cause of most incidents as currents!
- GL Waves are different from the Ocean



### Waves

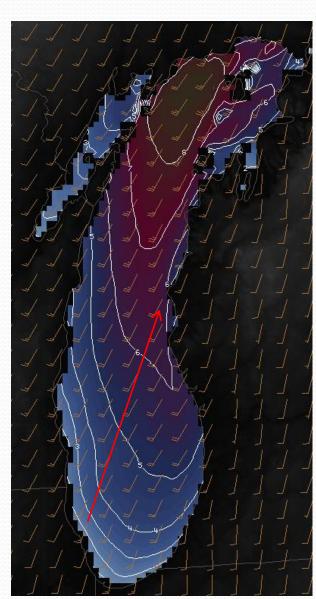
Key ingredients to building wave heights



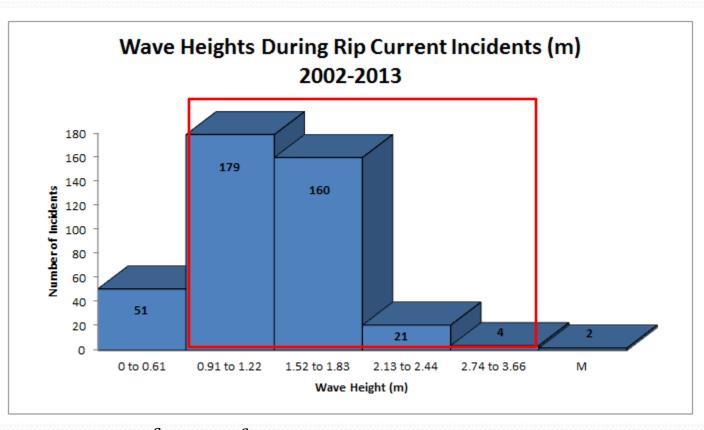
- Wind Speed
- Wind Fetch Length
- Wind Duration
- Stability

- Ocean Waves=long periods, swell (>9 seconds)
- <u>Lake MI Waves</u>= short periods, wind waves (<9 seconds





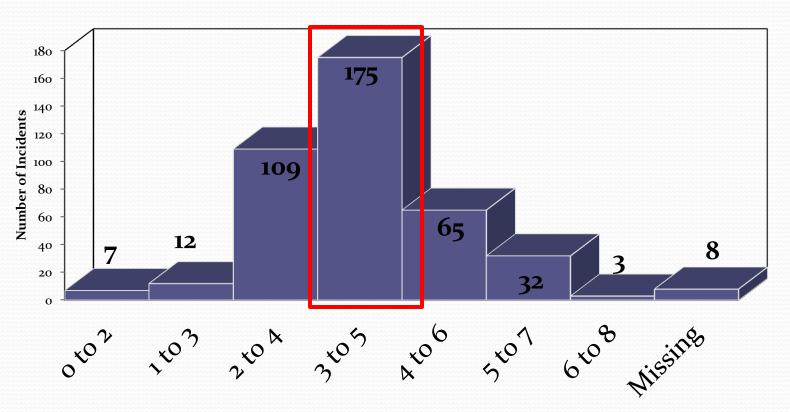
## **High Wave Action**



o-2 ft 3-4 ft 5-6 ft 7-8 ft >8 ft Missing

Wave Heights (ft) During the Incident

## Wave Period During Incidents 2002-2012



**Wave Period (seconds)** 

### **Problem:**

- \*High waves crashing over a swimmer's head every 3-5 seconds
- \*Currents more likely with higher waves: preventing a safe return to shore and pushing the swimmer into deeper water



Like swimming in a washing machine!!!

## Rip Currents

Classic/Sandbar type Rip Currents
Outlet-type rip currents

## What is a rip current?

- •A narrow jet of water moving swiftly away from shore, roughly perpendicular to the shoreline.
- Visual Clues:
  - Muddy/choppy water
  - •Break in the incoming waves



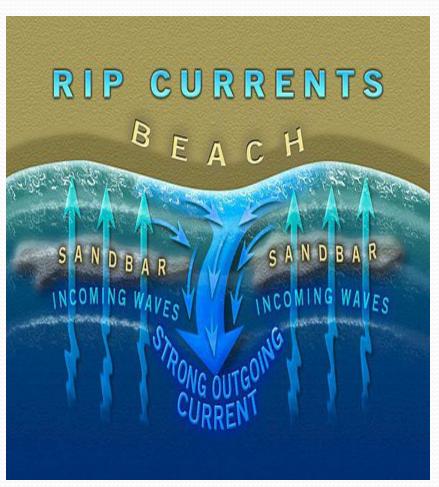
## Classic Rip Current Examples





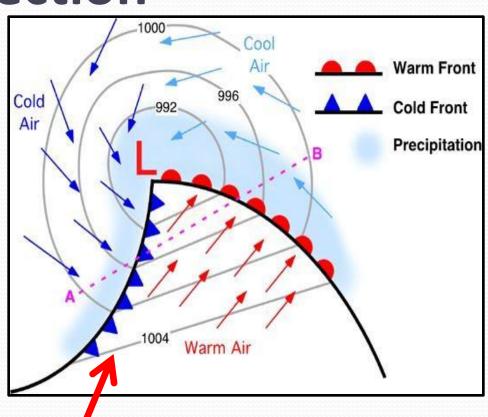
## **Classic Rip Currents**

- Water piles up unevenly along the shoreline
  - Onshore Winds/Waves
  - Higher Wave Heights
  - Gentle Sloping Beach
  - Sandbars
  - River mouths

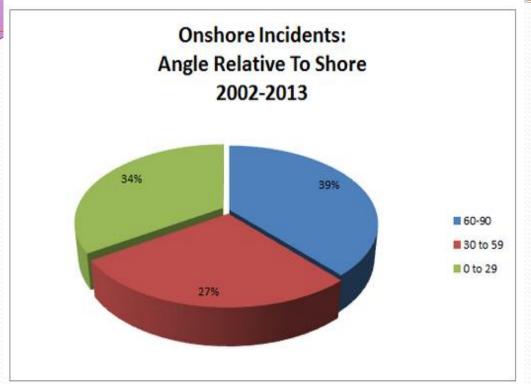


## Onshore Winds: Estimating Wave Direction

- Onshore wind flow generates waves moving towards shore
- Longer fetch (distance across lake) + Stronger winds for a long duration=bigger waves
- Bigger waves = more water piling up onshore
- Leads to rip currents on favorable beaches



People at beach: Nice day, warm and humid air



Current incidents happen when winds (and hence waves) are onshore. 96% of current related incidents on the Great Lakes occur with onshore winds/waves.

Structural currents are most common with waves at a more oblique (not exactly perpendicular) angles to shore. Rip currents are more likely with waves being perpendicular to shore.

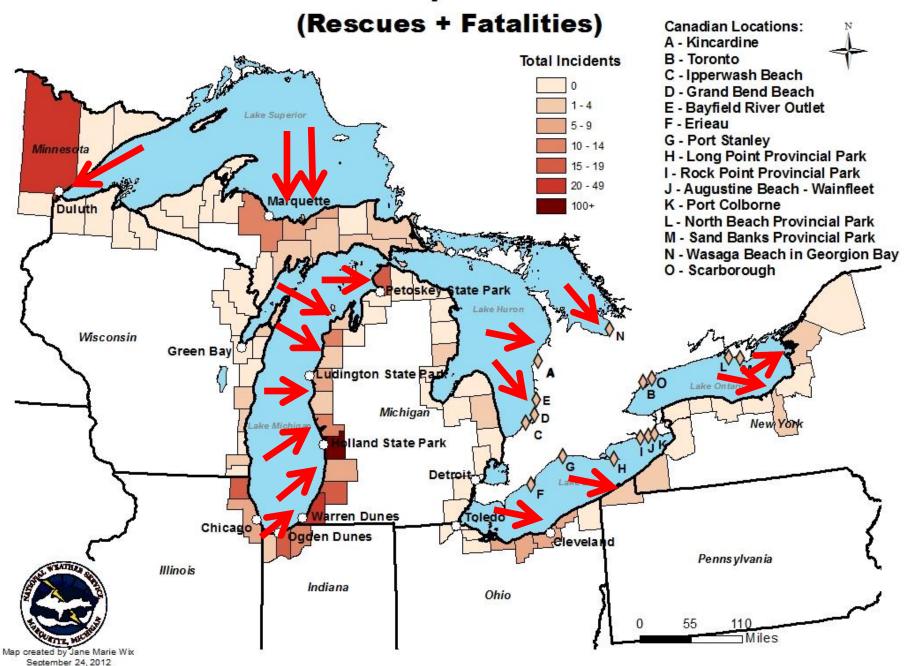
## Wave Direction (Relative to Shore)

\*60-90 Degrees is perpendicular to the shoreline-best for strong rip currents in the sandbars

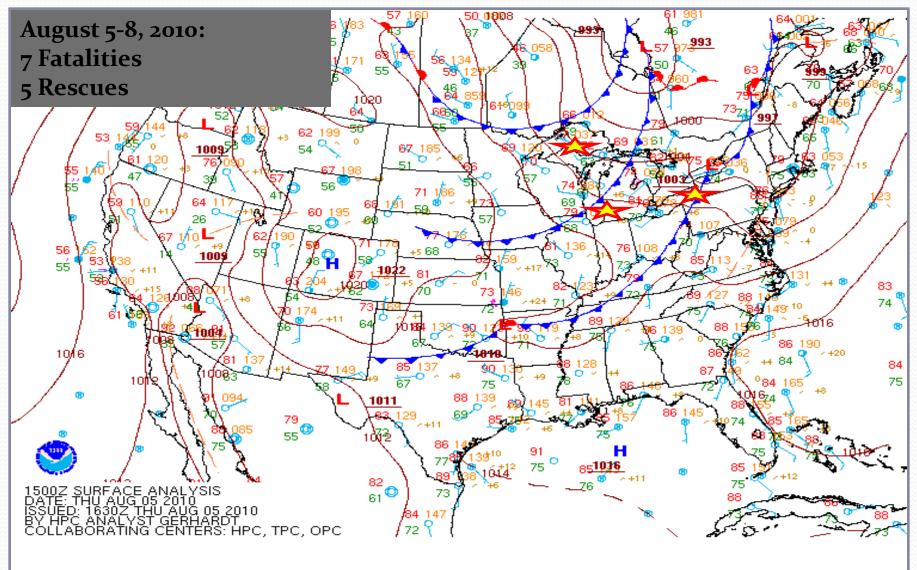
\*30-59 Degrees is when the longshore current is the strongest, which would lead to stronger structural currents near breakwalls or smaller and more numerous rip currents in sandbars.

\*o to 29 degrees would also result in stronger structural currents and more numerous rip currents in sandbars

#### Total Channel Current and Rip Current Incidents - 2002-2012

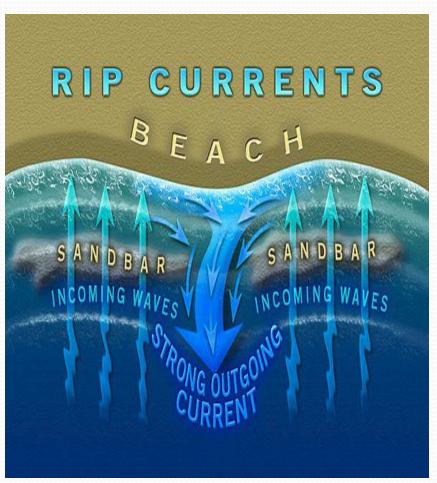


## **Cold frontal passage**



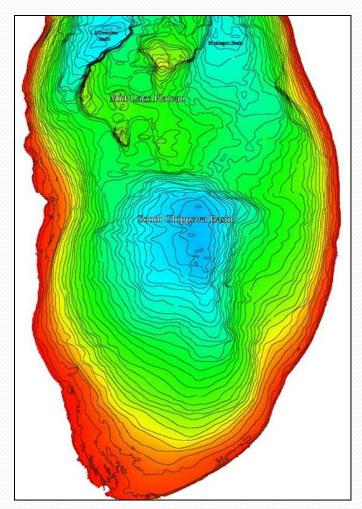
## **Classic Rip Currents**

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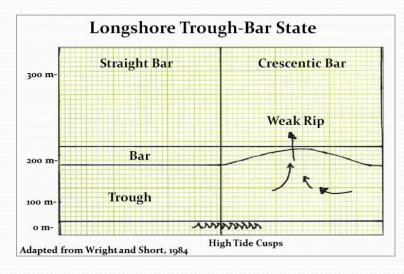


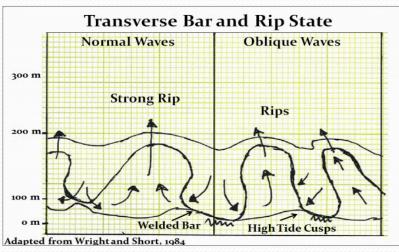
## Classic Rip Currents: Intermediate Beach Type

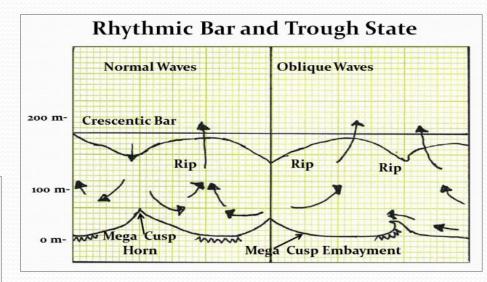




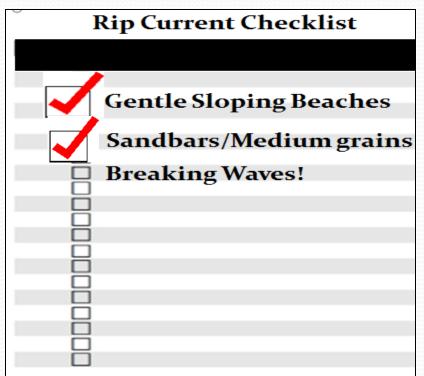
### Intermediate Beach States: Classic Rip Current Development







### Classic Rip Currents: Intermediate Beach Type

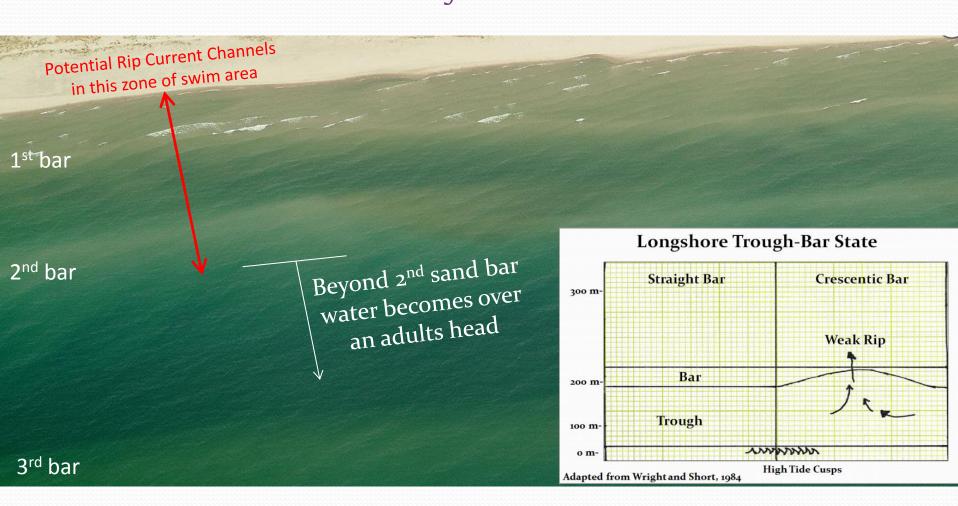




- outer bar is quite permanent and only affected / moved by the strongest of storms (very large waves)
- second middle bar is also fairly stationary and is only moved by large waves from moderate storms
- inner bar is the most mobile and can vary quite a bit, <u>our biggest</u> <u>unknown in the forecast process</u>

## Sandbar Structure

Muskegon State Park





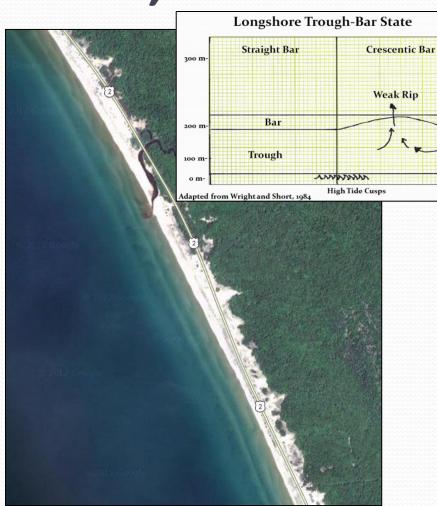
### Sandbars along the

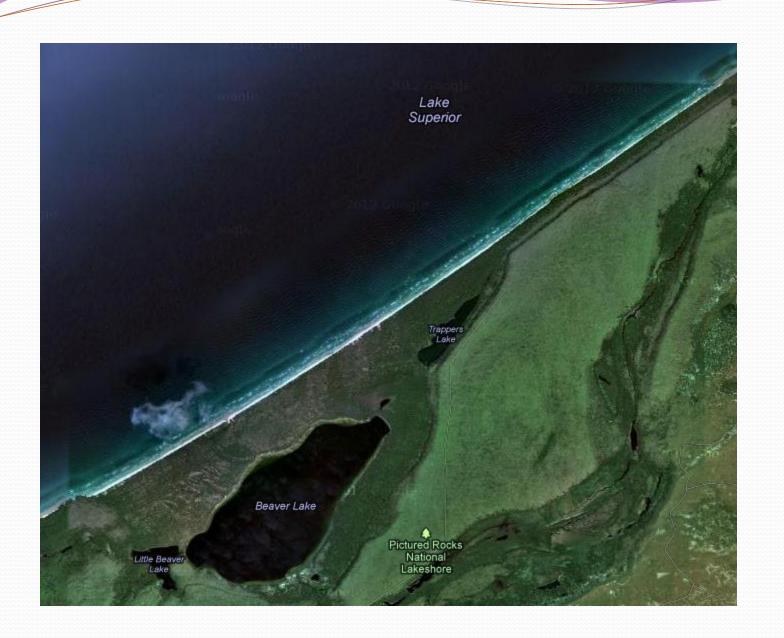


## US-2 Mackinac, MI

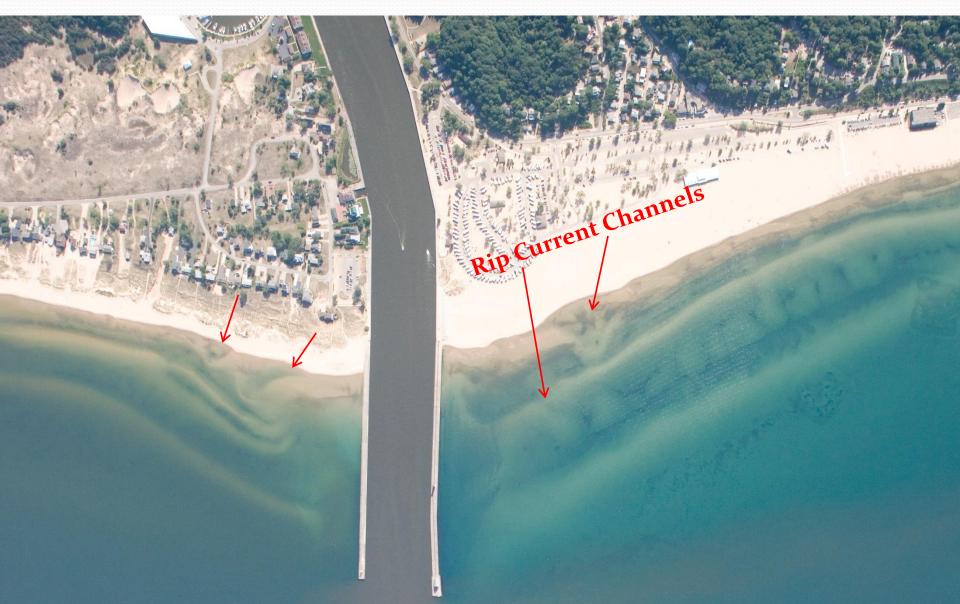
- Sandbars along the shore
- River outlets



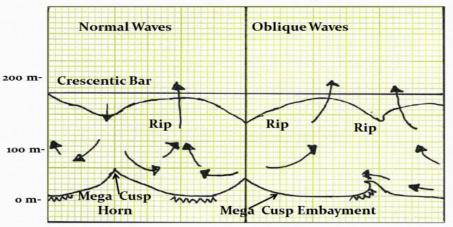


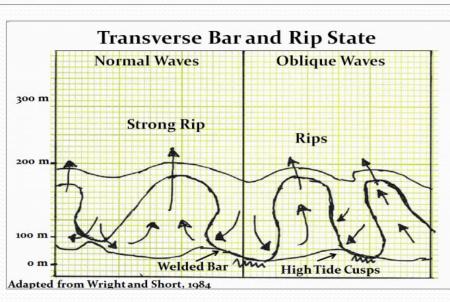


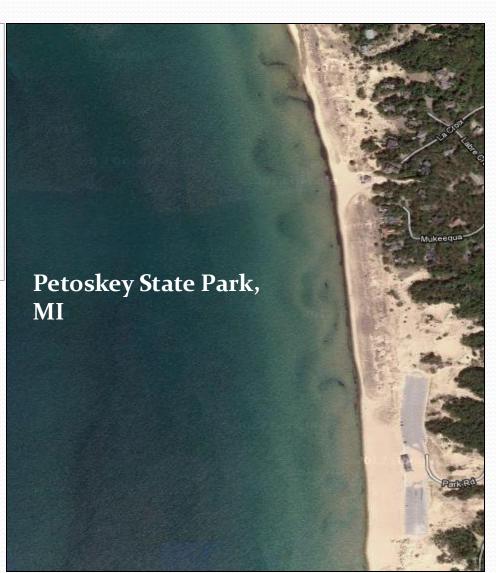
## **Classic Rip Currents**



#### **Rhythmic Bar and Trough State**







## Rip current System on Lake MI



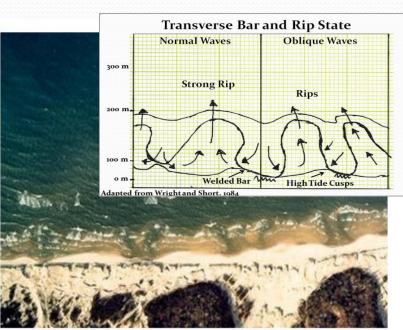
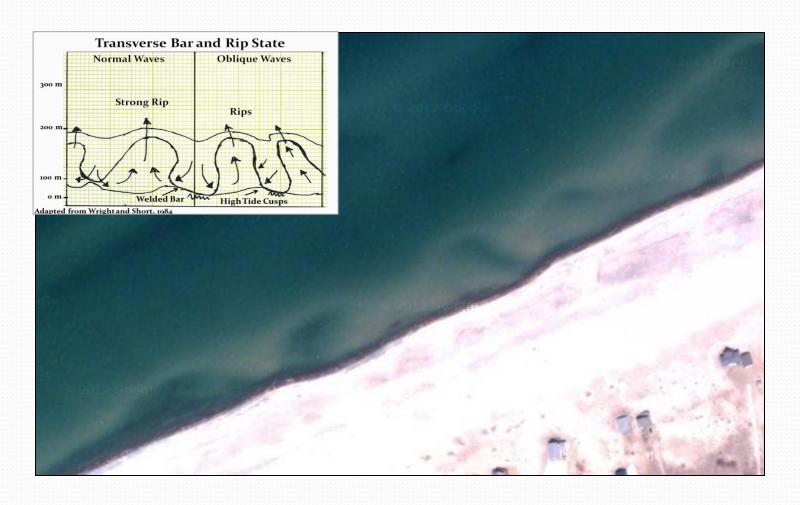


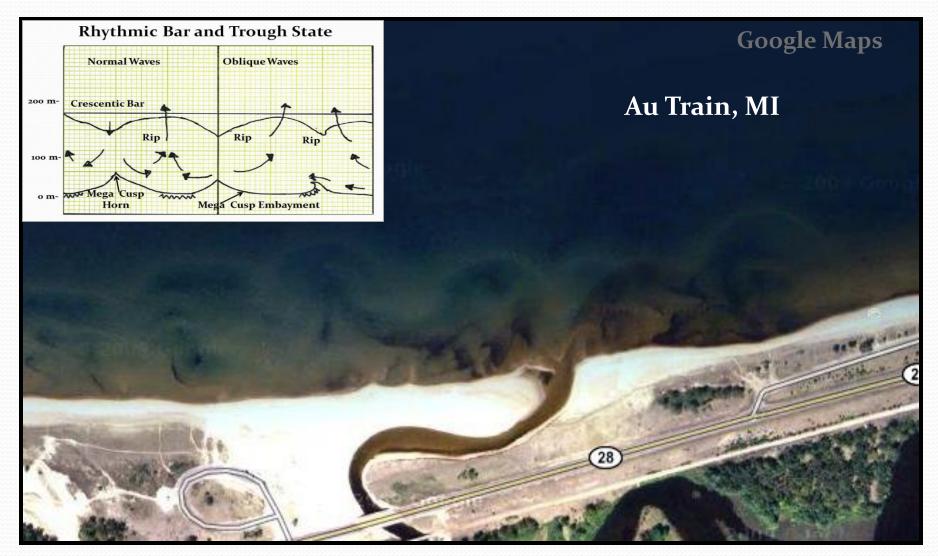
Figure 3. Coastal aerial photographs of two adjacent sections of Lake Michigan shoreline along Big Sable Point. The photo on the left shows a long linear, three bar system, while the photo on the right, taken only a few seconds later, as the aircraft progressed, shows a complex rip channel system.

[From Meadows et al, 2011]

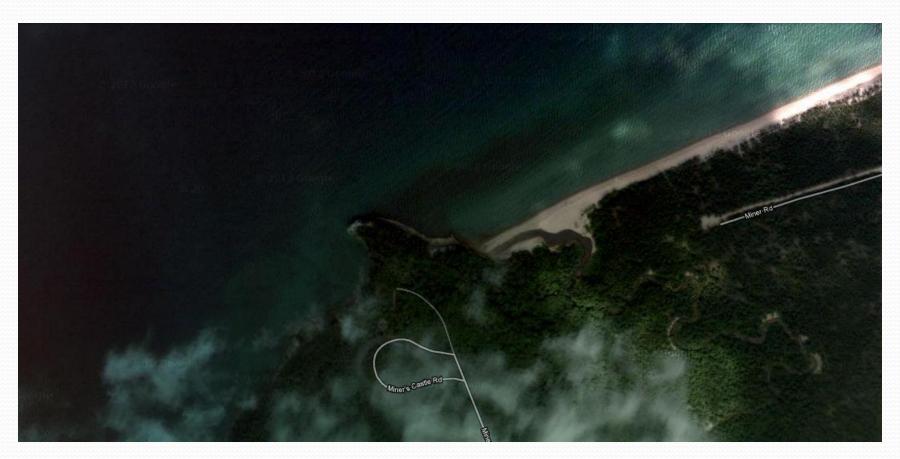


Grand Marais/Grand Sable Dunes: Lake Superior

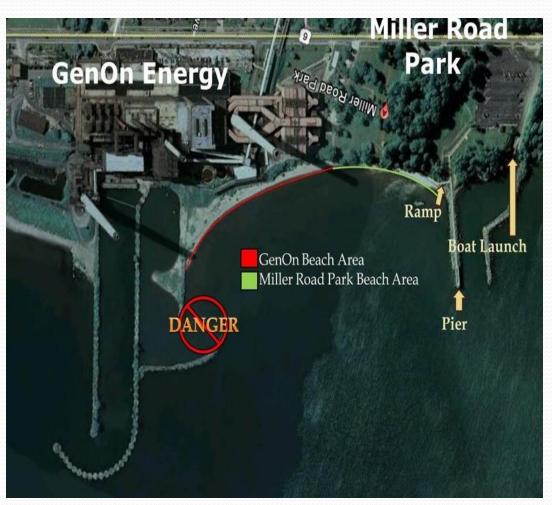
#### River mouths or outlets + Sandbars



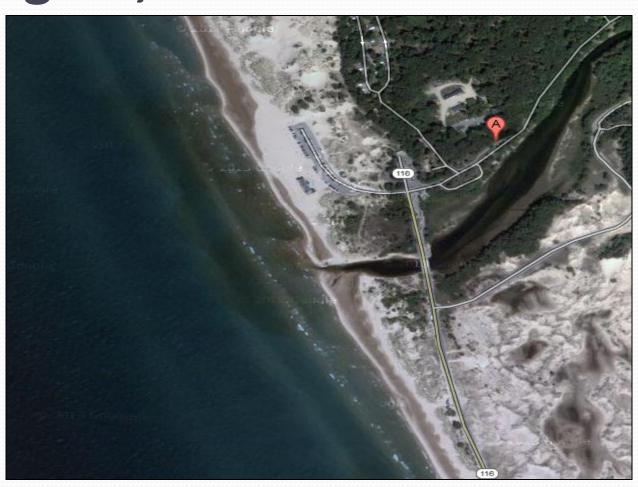
# Miner's Beach: River Mouth + Sandbars



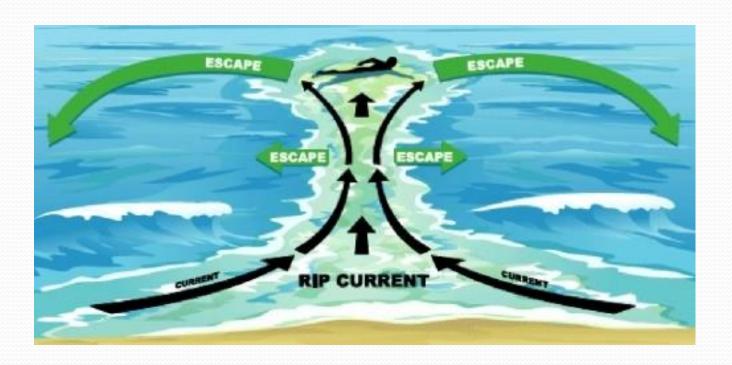
### River Outlet: Miller Rd Park Avon Lake, OH



#### Ludington, MI Sable River Mouth



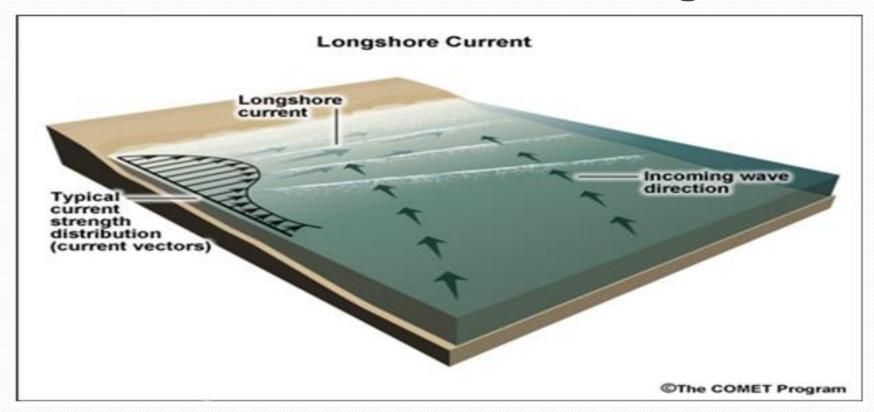
## Rip Currents: Sandbars and River Mouths



Swim Parallel to Shore to escape!

### Longshore Currents

### Longshore Currents: Develop as waves intersect the shoreline at an angle



#### **Longshore Currents**

- In strong North or South flow in Western Lower MI, longshore currents occur.
- These currents will exert a force on you making it difficult to remain in front of your spot on the beach. The current will push you down the beach over time.
- Children are especially susceptible to these currents in between the 1<sup>st</sup> and 2<sup>nd</sup> sand bars.
- To get out of swim directly back to the beach.



Incoming wind and wave direction

#### **Structural Currents**



#### **Structural Currents**

- A rip current that forms near a shoreline structure
- Develops as the longshore current intersects a breakwall or peninsula



# Survivor Quote: Rescued near the breakwall

- Holland State Park, August 3, 2011
  - "I was trying to swim parallel to shore because I knew I was in a rip current...but it wasn't working! The current was there too."
  - "I originally wasn't swimming near the breakwall, I was swimming quite a ways down the beach. I didn't notice how close I had drifted to it"

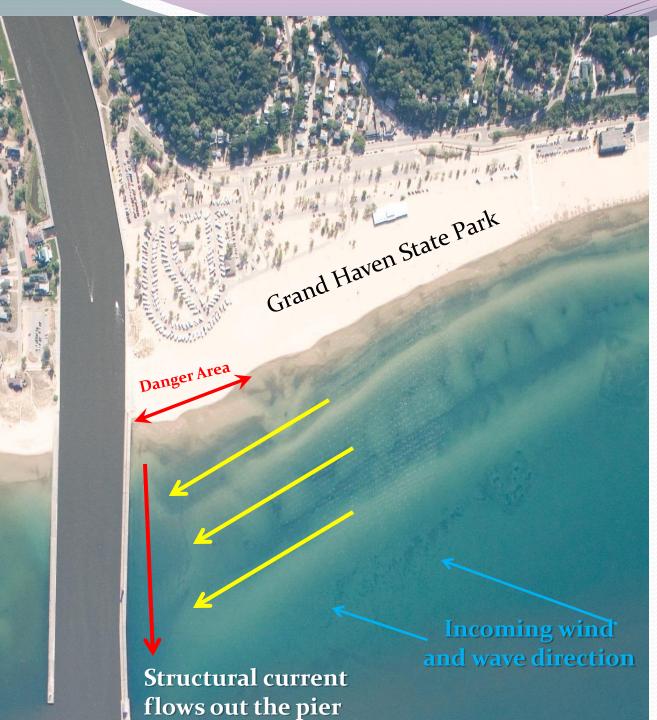
#### Sandbar Structure

Muskegon State Park near north breakwall



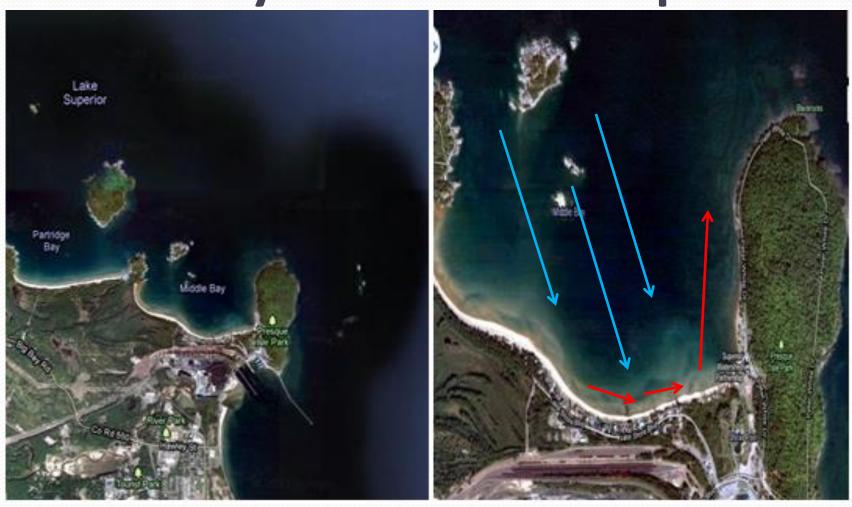
#### Problems:

- Longshore Current pushes victim into breakwall
- 2) Longshore current keeps victim near breakwall
- 3) Structural current pushes victims away from shore
- 4) Water becomes deeper as swimmer moves outward
- 5) Waves pounding over head, larger at the end of the breakwall
- 6) Water outlet at the end of the breakwall contributes to the flow moving lakeward

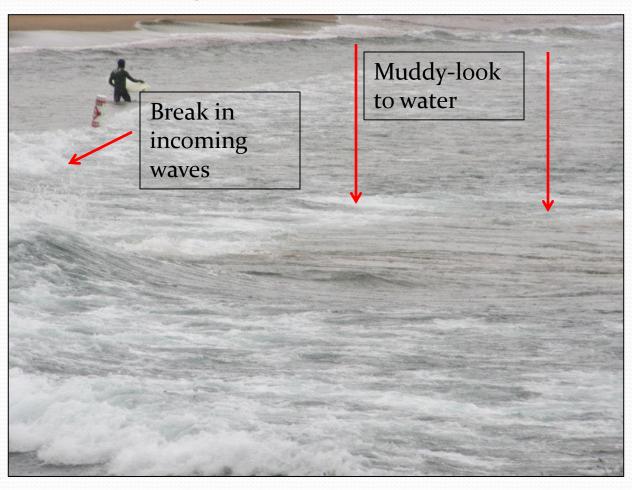


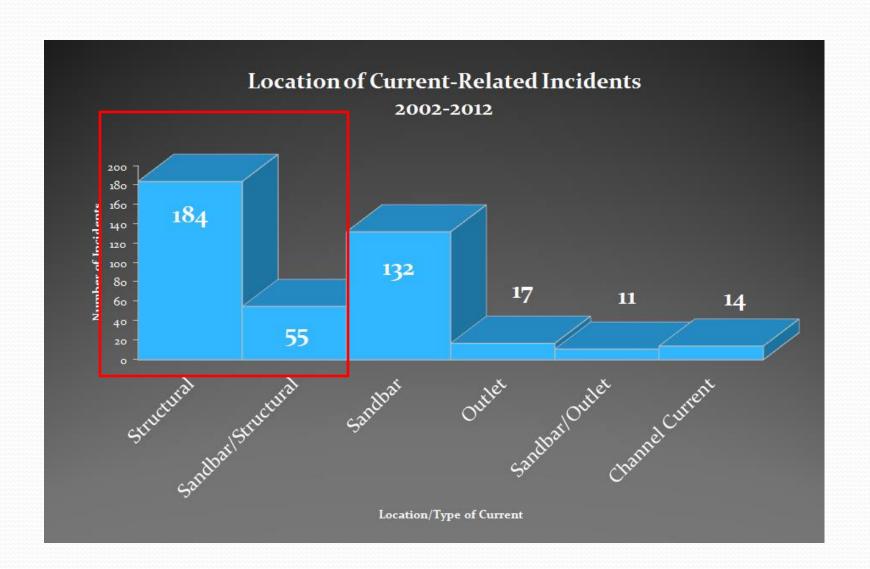


#### Middle Bay: North of Presque Isle



#### Middle Bay Structural Current



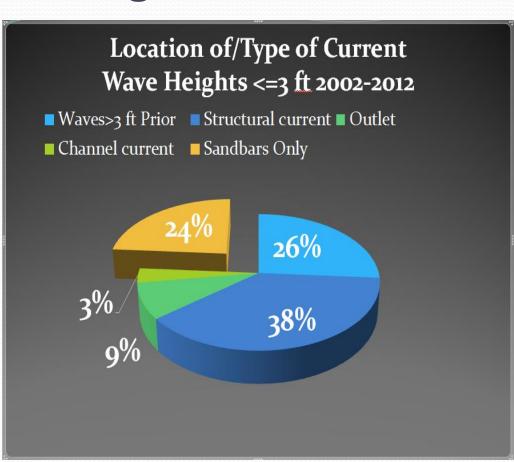


#### **Exceptions to the Rule**

When high waves are absent...

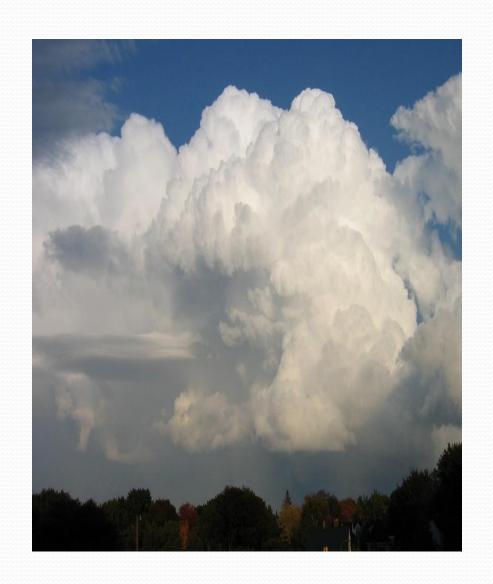
### Dangerous Currents can still be present even under low-wave height scenarios!

- There are a fairly large number of incidents [around 30%] that occur during low wave height scenarios
- Only 24% were not influenced by high waves, river mouths, or shoreline structures



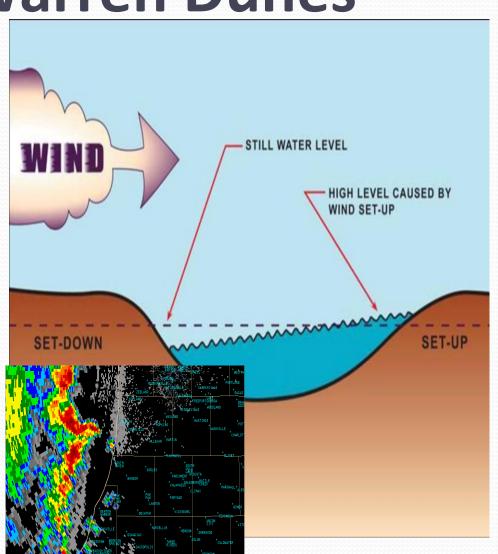
#### The 24%...

- Could be a function of the limitations of the database
  - Observations used for these sites could have been >50 miles away
  - May not account for tstorms kicking up localized waves
- Seiches



July 4, 2013, Warren Dunes

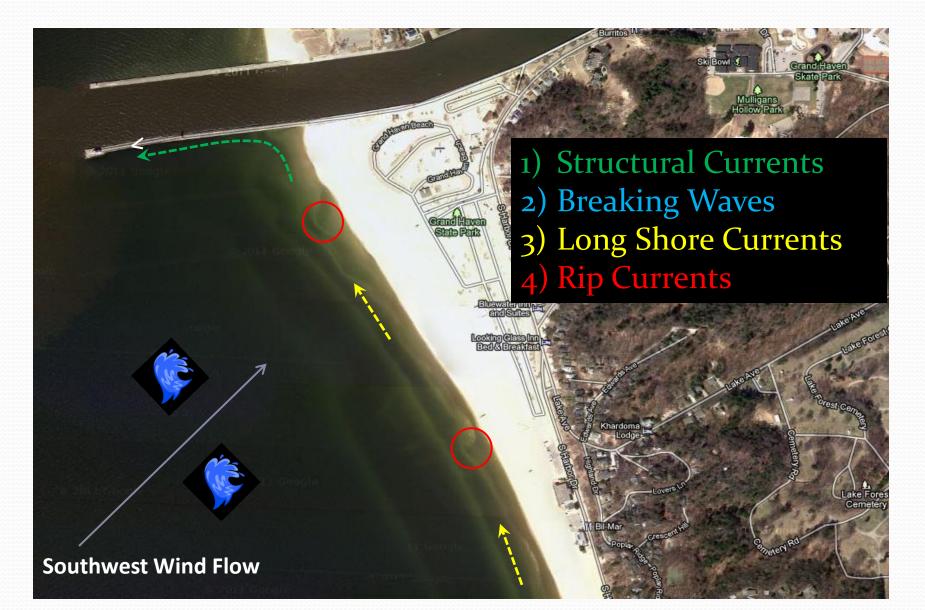
- Large storm moved through in AM
- Later in the afternoon, waves 2-3 ft
- 7 adults drowned in a 5 hr period along the Warren Dunes shoreline
- Seiche motion: water sloshing back and forth from the storms influence on the water sfc
- Acts similar to low tide on the ocean [enhances rip currents]
- Strong storm could have modified the sandbars



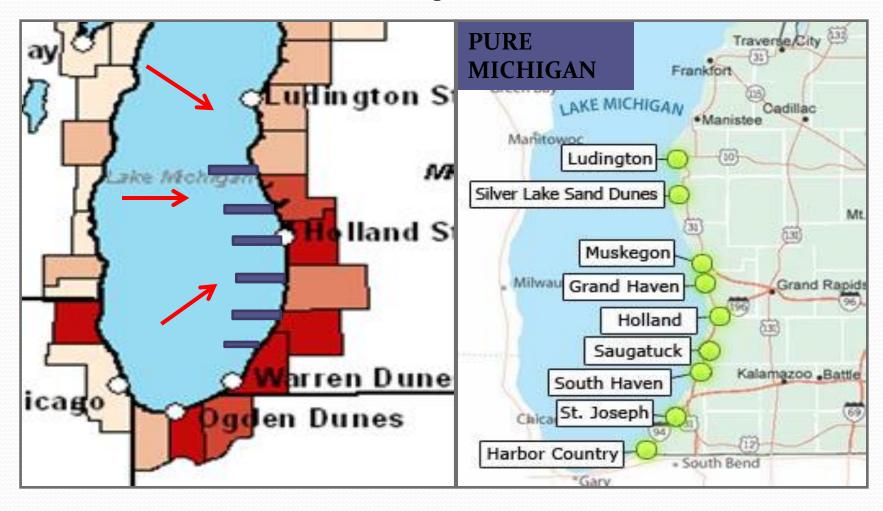
#### Why Lake Michigan?

Factors contributing to the most drowning fatalities and rescues of all the Great Lakes

#### Most Lake MI Beaches...



# Popularity + favorable conditions/Locations



#### Conclusions

- High Waves likely as culpable as currents for drowning fatalities
- Structural Currents (+high waves) cause the most drowning fatalities on the Great Lakes, especially Lake Michigan
  - No escape route!
- Rip Currents happen [typically during high waves] in areas near river outflow and on gently sloped beaches with complex sandbars
  - Swim Parallel to shore to escape!
  - Watch out for a-typical conditions: (strong thunderstorms over the lake leading to seiche-like motions)
- Longshore currents not individually responsible for deaths, but can drag swimmers towards shoreline structures!
  - Escape: Swim towards shore

#### Safety Recommendations

- 1) Check the NWS forecast! Outlooks, statements, etc to prepare for high risk days ahead of time!
- 2)Keep people away from shoreline structures!
  - Ocean studies suggest at least 100 feet away from structures, though new studies with Great Lakes currents will likely provide a more accurate measurement
- 3) Keep people out of high wave situations if wading/general swimming (no flotation device/Surf Boards, etc)
  - 3 to 5 ft or higher for adults (NWS High Swim Risk)
  - 2 to 4 ft smaller children/very inexperienced swimmers (NWS Moderate Swim Risk)
  - Dangerous rip current development more likely at wave heights in the 3-4 ft range and higher

### Questions?

Contact:

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